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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Insulating Electrical Machines

We, DANFOSS A/S, a Danish Company, of Nordborg, Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and apparatus for the application of an insulating coating to the slots of the stator or rotor of an electrical machine, using as raw material a powder which is finely dispersed and suspended in air.

The slots of the stator or rotor of an electrical machine have recently, instead of being provided with inserted slot insulation, often been provided with a plastic coating applied directly to the slot wall. This method has a number of advantages: the adherence of the insulation in the slot is better, the insulation can be varied in thickness and shape, e.g. become thicker towards the front and overlap onto the front face and it is particularly suitable for mass production, etc. However, difficulties occur if all the slots are to be treated at once. When applying a liquid plastic, this responds to gravity, so that extreme unevenness occurs.

The only method which has hitherto proved practical uses a plastic material in powder form. Heat-hardening synthetic resin powder is fluidised in an open-topped tank, i.e. finely dispersed in the air in a fluidised bed. If the stator or rotor is now dipped into the fluidised powder from above, it becomes covered with an even layer of plastic. The disadvantage is that the stator or rotor is completely coated with plastic although the plastic layer is only required in the slots. The result is wastage of material and the need to remove the plastic again at points where it can cause trouble.

The aim of the invention is to retain the advantages of the powder application method but to eliminate its disadvantages.

This is achieved according to the invention by the fact that the powder is fed by a directed stream of air to the slot area through a mask covering the front of the machine component but leaving the slot area exposed.

In this way, not only is the part of the front face directly covered by the mask protected, but also the opposite end face of the stator stack, and in a stator the whole peripheral surface is protected. In addition, no difficulty is involved in covering the inner peripheral surface at the air gap with a cylinder made of a material which does not react with the plastic powder. Thus, for example, when heat-hardening plastics are being used the cylinder conveniently consists of polytetrafluorethylene. In spite of this, the slots are provided with an adequate coating of plastic powder, since a stream of powder is driven through the slots.

A further advantage of the process according to the invention consists in the fact that the very expensive fluidising of the plastic powder can be omitted. It is sufficient, in fact, if free-falling powder is conveyed through the mask apertures by a transverse current of air.

Apparatus for carrying out the method outlined only requires a chamber for the finely dispersed powder suspended in air, the side wall of the chamber having a mask with apertures corresponding to the slot areas and the opposite side wall having a blower device. In particular, a powder spraying device can be fitted to the top and a collecting device to the bottom of the chamber, a return feed device preferably being provided between the collecting and spraying devices.

In many cases it is preferable to use several masks with different apertures consecutively, for example in order to produce certain insu-

[*Price 4s. 6d.*]

lating layer forms and thicknesses in the slots and on their edges. Various movable masks can also be arranged if different stators and rotors are to be treated using the same apparatus.

Part of the powder fed through the slots will emerge from the other end of the machine component being treated. The powder can be collected there and fed back again into the continuous working process. It is, however, particularly advantageous if two devices according to the invention are provided, having their masks facing towards each other. In this case, one apparatus acts as collecting device for the excess powder fed by the other apparatus. If the two apparatuses act one after the other on the same machine component an even coating from both sides can be obtained and also very long slots can be coated in this way.

In a preferred embodiment, the motor component being treated is held at a slight distance, e.g. 5 mm., from the mask. Thus the motor component may, for example, remain during the process on a conveyor passing directly in front of the mask. In addition, the insulating layer begins with a gradual transition in the slot area at the front face, so that the sharp edge at the beginning of the slots is rounded off somewhat. If the motor component is hot, the gap provides for such an adequate cooling of the mask that no heat-hardening resin collects there.

If a heat-hardening plastic is used as insulating material, it is an advantage to subject the machine component to prior cleaning, during which process it is heated. Either the machine component reaches the reaction temperature of the plastic with the amount of heat thus applied, or it needs only a relatively small amount of heat added to bring the machine component to the reaction temperature. It is to be recommended, for example, that the cleaning should be carried out in the saturated vapour of a chemical cleaning agent, since a very considerable amount of heat is transmitted to the machine component due to condensation. If perchlorethylene is used, for example, the machine component reaches a temperature of approximately 120° C. After cleaning, the machine component can then be dried by further heating, and in this way reach a temperature of approximately 210° C, at which epoxy resin, for example, melts and hardens.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawing of which:—

Fig. 1 is a diagrammatic cross-sectional side elevation of a machine forming part of an apparatus according to the invention, and

Fig. 2 is a diagrammatic cross-sectional and elevation of the machine shown in Fig. 1 and also of further parts of an apparatus according to the invention.

On the left-hand and right-hand side of the conveyor belt 1, on which a stator 2 being treated is moved forwards step by step, two identical devices 3 and 3^1 are arranged. Only the left side of each of these two devices will be described below. The chamber 4 is provided on one side wall with a movable shutter 5, which carries three masks 6, 7 and 8 with different apertures. In the opposite wall there is an aperture 9 and behind this a nozzle 10 (or several nozzles) with compressed air feed 11. At the top a spraying device is provided which consists of the storage chamber 12, spray nozzles 13 and a vibratory sieve 15 driven by a motor 14. Underneath, a chute 16 leads to the collecting chamber 17, from which a conveyor worm 18 leads back into the storage chamber 12.

In operation, the storage chamber 12 is filled with plastic powder. As soon as the vibratory sieve 15 is set in operation, finely dispersed powder falls downwards through the chamber 4. At the same time the air supply to the nozzle 10 is switched on and acts on the falling powder with its directed stream of air. Only where the masks leave openings can the air stream emerge from the chamber and thus take with it some of the falling powder.

The stator 2 moving forward on the conveyor 1 is arranged in front of a mask, e.g. the mask 7, in such a way that its slots 19 are in line with the apertures in this mask. A cylinder 20 is inserted in the stator so that only the slots 19 form channels which allow the passage of the streams of air emerging from the apertures in the mask and saturated with powder. The stator 2 has a temperature which is higher than the reaction temperature of the plastic powder. Whilst passing through the slots 19, some of the powder is deposited on the slot wall and there forms the required insulating coating, whilst the remainder emerges again at the other end of the slots. If the shutter 5^1 of the apparatus 3^1 is completely opened or a mask similar to the mask 6 is in the working position, the unused powder can be collected in the collecting chamber 17^1 of the apparatus 3^1 and used again in this apparatus.

In the present embodiment the stator 2 should first of all be brought on its conveyor belt 1 into a cleaning apparatus 21, which is filled with perchlorethylene saturated vapour, which can be produced, for example, by heating perchlorethylene liquid 22. The stator leaves the cleaning apparatus at a temperature of approximately 120° C and reaches a drying device 23, in which several heating members 24 apply further heat to the stator. It leaves the drying device at about 220° C. In the next phase of the working cycle it arrives between

the two apparatuses 3 and 3^1. These work with epoxy resin powder, the reaction temperature of which is approximately 210° C.

In this working position the device 3 is first of all operated with the mask 8 and then with the mask 7, so that the device 3^1 has the mask 6 in the working position for that device. After the stator has been treated from one side, the apparatus 3 is switched off, then the mask 6 is brought into the working position whilst the apparatus 3^1 is switched on and the stator 2 is treated from the other side, first with the mask 8 and then with the mask 7. This method of operation can easily be automated by means of an electrical control system dependent on the working cycle of the conveyor belt.

It is possible to modify the embodiment illustrated in many respects without departing from the basic principle of the invention. For example, the directed stream of air can also act on fluidised powder and in this way feed the suspended powder through the mask apertures. The directed stream of air can also be produced by providing an excess pressure in the chamber 4 which can only escape through the mask openings. If it offers any advantage, some other gas can be used as carrier instead of air. For the fine dispersion of the powder in the air, further possibilities exist; for example, the powder can be fed direct into the conveying air stream at a nozzle station. The method is suitable not only for heat hardening plastics, but also for two-component plastics for example, whereby one component is applied to the slots in any required manner and the other component is then applied by the method according to the invention.

WHAT WE CLAIM IS:—

1. A method for the application of an insulating coating to the slots of the stator or rotor of an electrical machine, using as raw material a finely dispersed powder suspended in air, in which the powder is fed by a directed stream of air, through a mask covering the end of the machine component but leaving the slot area exposed, into said slot area.

2. A method according to claim 1, in which free-falling powder is fed through the mask apertures by a transverse stream of air.

3. A method according to claim 1 or claim 2, in which several masks with different apertures are used one after the other.

4. A method according to claim 1, 2 or 3, using a heat-hardening plastic as insulating material, in which the machine component is previously subjected to a cleaning process during which it is heated.

5. A method according to claim 4, in which the cleaning takes place in the saturated vapour of a chemical cleaning agent, such as perchlorethylene.

6. A method according to claim 4 or 5, in which the machine component, after cleaning, is dried by further heating.

7. Apparatus for carrying out the method according to any of claims 1 to 6, including a chamber for the finely dispersed powder suspended in air, said chamber having one side wall with a mask with apertures corresponding to the slot areas and the opposite wall having a blowing device.

8. Apparatus according to claim 7, and provided with a powder spraying device at the top and a collecting device on the underside of the chamber.

9. Apparatus according to claim 8, provided with a return feed between the collecting device and the powder spraying device.

10. Apparatus according to claim 7, 8 or 9, in which several masks, each of which may individually be brought into use, are inserted in the chamber wall as movable shutters.

11. Apparatus according to any of claims 7 to 10, in which the inner peripheral surface at the air gap is covered by a cylinder, preferably made of polytetrafluorethylene.

12. Apparatus according to any of claims 7 to 11, including two assemblies of masks facing towards each other.

13. Apparatus according to any of claims 7 to 12, and including a support for the motor component which holds the latter at a slight distance from the mask.

14. Apparatus substantially as described and illustrated with reference to the accompanying drawings.

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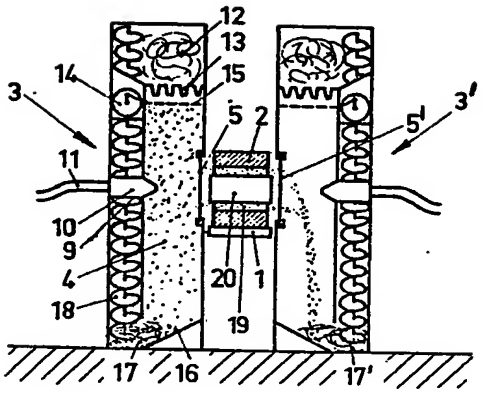
1046086 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1



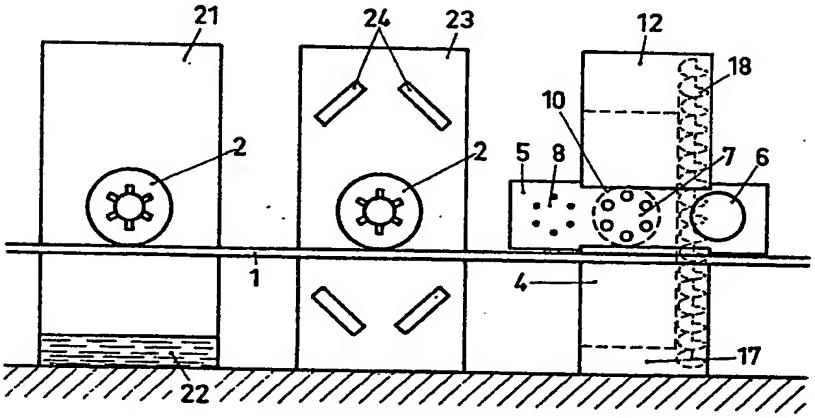


Fig.2